

*An introductory Essay to the doctrine of Sounds, containing some proposals for the improvement of Acousticks ; As it was presented to the Dublin Society Nov. 12. 1683. by the Right Reverend Father in God Narcissus Lord Bishop of Ferns and Leighlin.*

BEING to treat of the Doctrine of *Sounds*, I hold it convenient to premise something in the general concerning this Theory ; which may serve at once to engage your attention, and excuse my pains, when I shall have recommended them, as bestow'd on a subject not altogether useless and unfruitful.

And for this purpose I shall omit to speak any thing of the *Excellency* of the matter in hand ; though it might be celebrated by Arguments drawn from several Topicks, and particularly from this, that new discoveries and improvements may be made, both as to the *Generation, Propagation* and *Reception* of Sounds into the Sense ; which in a peculiar manner agrees to this, above the object of any other Sense whatsoever. I shall, I say, omit these things, and apply my self wholly to the *Usefulness* of the Theory, that we are now falling upon ; which I think cannot better be discovered, than by making a comparison 'twixt the Senses of *Seeing* and *Hearing* as to their improvements. I mean, by shewing, that this latter of *Hearing*, is capable of all those improvements which the Sense of *Seeing* has received from Art ; besides many more advantages, that the *Ear* may enjoy, by the help of our Doctrine, above the *Eye* ; all which moreover will be of as great benefit to mankind, as any thing that *Opticks* have yet discovered, if not of greater ; which, with some other preeminencies that it has upon another Score, will happily render *Acousticks* the nobler Science of the two.

In order to the making good what I but now promised of the Comparison of these two Faculties of *Seeing* and  
*Hear-*

*Hearing*, as to their improvements, I observe,

That *Vision* is threefold, *Direct*, *Refracted*, and *Reflex'd*; answerable whereunto we have *Optick*, *Dioptricks*, and *Catoptricks*.

In like manner *Hearing* may be divided into *Direct*, *Refracted*, and *Reflex'd*; whereto answer three parts of our Doctrine of *Acousticks*; which are yet nameless, unless we call them *Acousticks*, *Diacousticks*, and *Catacousticks*, or (in another sence, but to as good purpose) *Phonicks*, *Dia-phonicks*, and *Cataphonicks*.

1. *Direct Vision* has been improv'd two ways; *ex parte Objecti*, and *ex parte Organi vel Medij*.

1. *Ex parte Objecti* *Direct Vision* has receiv'd advantages by the Arts of *Producing*, *Conserving* and *Imitating Light* and *Colours*, which are the Objects of *Vision*.

1. For the Art of *Producing Light*, we have the Frication of all hard Bodies, that beget Fire; especially of the Flint and Steel; and instead of the Flint, most hard Stones (as well as the Cane) may be us'd to the same effect; as upon trial I have found. Add hereto the lately invented *Phosphorus*, which is a new and admirable way of producing a *Lucid substance* by Art, out of a body in itself not *Lucid*; and therefore may not unfitly be term'd an *Artificial production of Light*.

And then of the Art of *Conserving Light*, the *Lapis Bononiensis* is a notable instance; and so happily were the *Sepulchral Lamps* of the Ancients.

2. As to *Colours* 'tis the greatest part of the Art of *Dying* to be able to *make* and fix (that is preserve) them; and the *Painters* and *Limners* will own it to be no small part of their Skill to be able well to *Mix* (that is in effect, to *Generate*) *Colours*.

3. For *Imitation of Light* and *Colours* 'tis well known how far *Perspectiv* with the Art of *Limning* and *Shad-owing*, have gone therein, which all tend someway to the Advance or Improvement of *Direct Vision*.

Add to all these, That a *due Application of Light to the Object* renders it Visible, if it were not so before ; as appears from a dark room illuminated : or else makes it better and more truly discernable by the Sense of *Seeing* ; if before it might have been discern'd.

Hence the same *Colour* in a divers Light will appear different, and no *Pictur* can well be discern'd or judg'd of, but by it's true *Light*. Besides, the *Limner* will assure you, that he can hardly make true work or hit the Air of a face exactly, unless he draw by a *North-Light*, by reason of the Steadiness of that, and the uncertainty of all other *Lights* whatsoever. Which things shew, that the *Art of duly applying Light to the Object* does very much help and improve Vision. So also does the due placing of the *Object*, as to *Height and Distance*. But to enumerate all things, that help *Direct Vision*, would be infinite.

2. *Ex parte Organi v. l. M. dij.* Direct Vision has been improved by making use of a *Tube*, without Glasses, or a mans clos'd hand, to look throw ; which admitting into the *Eye* only the principal raies, that come directly from the *Object*, do very much strengthen and clear the Sight, by excluding all the Collateral raies, that crouding into the *Eye*, together with the direct ones, would confound and disturb it, partly by mixing and interfering with the Direct raies, and partly ( or rather chiefly ) by too much enlightening the fund of the *Eye*, wherein Vision is truly ( though then imperfectly ) made.

On this is founded the Art of making *Spectacles* without Glasses ; ( as well as *Tubes* ) which is done by putting into the Glass-holes ( instead of Glasses ) two short *Tubes* of between 3 and 4 inches long ( for their length is to be vary'd according to the age or eye of the beholder, and so also is the Diameter of the extreame ends ) which *Tubes* being made of *Spanish Leather* ( or past-board, or some such like matter ) and black'd on the inside, are so to be plac'd, as that the visual raies, receiv'd throw them may meet in  
one

one point ( or rather issue out from one point ) of the Object standing at such a due distance, as the person may clearly and distinctly see it, or according to his length of Sight (as ABC, in the first Fig.)

And these *Spectacles* may be supposed better for preserving the Sight, then the ordinary ones with Glasses because they represent the Object more naturally, and withal more clearly and distinctly to the Eye, then the other, whose refracted raies being collected together with the right ones in the Glasses, do somewhat confound good Vision; as before. Especially if the visive power be strong enough to be sufficiently determin'd by the right raies alone.

For I speak now of preserving a good Eye by these Spectacles; which holds in proportion true also of a bad one. Because those Raies ( both right and refracted ) being collected and brought so near the Eye ( whether good or bad ) as the Spectacles are usually plac'd, do too much affect it, both by their own brightness, and also by the brightness of the colours of the Object ( when they are bright ) which is brought very near also; whereby the Eye is dazl'd and confounded; unless there be a strong attention and *conatus* of the Spirits, whereto the bright Raies do certainly engage them; which of necessity weakens Vision; especially if these Glass-spectacles be much us'd.

Wherefore the now describ'd new Tube-spectacles, contributing so much to the help and preservation of Sight, may well be counted an improvement of *Direct Vision*; because they convey the raies to the Eye without any kind of refraction whatsoever. Seeing the same Object also through various holes, plac'd at certain distances, does somewhat alter Vision; but of this perhaps more hereafter.

Now as *Direct Vision* has thus been improv'd; so likewise *Direct Hearing* partly has already receiv'd, and partly may ( by the Doctrine whereof we are treating, if well cul-

cultivated) farther receive as great and notable Improvements, both *ex parte* Objecti, and *ex parte* Organi vel Medij.

1. As to the *Object* of hearing, which is Sound, improvement has been and may be made, both as to the *Begetting*, and as to the *Conveying* or *Propagating* (which is a kind of *Conserving*) of Sounds.

1. As to the *Begetting* of Sounds. The Art of Imitating any Sound, whether by *Speaking* ( that is pronouncing ) any kind of Language, ( which really is an Art; and the *Art of speaking* perhaps one of the greatest ) or by *whistling* or by *Singing* ( which are allow'd Arts ) or by *Hollowing* or *Luring*, ( which the Huntsman and Faulkner would have to be an Art also ) or by *Imitating* with the Mouth ( or otherwise ) the voice of any Animal; as of *Quails*, *Cats* and the like, or by *Representing* any Sound begotten by the Collision of Solid Bodies or after any other manner; these are all *Improvements* of *Direct Hearing*, and may be improv'd.

Moreover the skill to make all sorts of *Musical Instruments*, both Ancient and Modern, whether *Wind Instruments* or *String d*, or of any other sort, whereof there are very many ( as *Drums*, *Bells*, the *Sistrum* of the Egyptians, and the like ) that beget ( and not only propagate ) Sounds; the skill of making these, I say, is an Art, that has as much improved *Direct Hearing*, as an Harmonious Sound exceeds a single and rude one, that is, an immusical *Tone*, which Art is yet capable of farther Improvement. And I do hope, that by the rules, which may happily be laid down, concerning the *Nature*, *Propagation* and *Proportion* or *Adapting* of Sounds, a way may be found out, both to improve *Musical Instruments* already in use, and to invent new ones, that shall be more sweet and luscious, then any yet known. Besides that by the same means *Instruments* may be made, that shall imitate any sound in Nature, that is not Articulate; be it

it of Bird, Beast, or what thing else soever.

2. The *Conveying* and *Propagating* (which is a kind of *Conserving*) of Sounds, is much help'd by *duly placing the Sonorous Body*, and also by the *Medium*.

For if the *Medium* be *Thin* and *Quiescent*, and the *Sounding body plac'd conveniently*, the Sound will be easily and regularly propagated, and mightily conserv'd. I say,

1. If the *Medium* be *Thin* and *Quiescent*; because it otherwise caueth a *Refracted Sound*; of which afterwards. Hence in a *Still Evening* or the *dead of the night* (when the wind ceases) a Sound is better sent out and to a greater distance, then otherwise; though much of this may be ascrib'd to it's *Refraction* also.

2. I say, that the *Sonorous Body* must be plac'd conveniently, near a *Smooth wall*, near *Water*, or a *Plain*, whose surface is even.

1. Near a *Smooth wall*, either *Plane* or *Arch'd* (*Cycloidically* or *Elliptically*, rather then otherwise; though a *Circular* or any *Arch* will do; but not so well.)

Hence in a *Church*, the nearer the *Preacher* stands to the wall (and certainly tis much the best way to place *Pulpits* near the wall) the better is he heard, especially by those, who stand near the wall also, though at a greater distance from the *Pulpit*; those at the remotest end of the *Church*, by laying their *Ears* somewhat close to the wall, may hear him easier then those in the middle.

Hence also do arise *Whispering places*. For the voice being applied to one end of an *Arch*, easily roul's to the other. And indeed were the *motion* and *propagation* of sounds but rightly understood, 'twould be no hard matter to contrive *Whispering places* of infinite variety and use. And perhaps there could be no better or more pleasant hearing a *Consort of Musick*, then at such a place as this; where the Sounds rouling long together, before they come to the *Ear*, must needs consolidate and imbody into one; which becomes a true composition of Sounds, and is the very life and soul of *Consort*.

2. If the Sonorous body be plac'd near *Water* the sound will easily be convey'd, yet mollified; as experience teacheth us from a Ring of *Bells* near a river and a great *Gun* shot off at Sea; which differ much in the strength, and yet softness and continuance or propagation of their Sounds, from the same at land; where the Sound is more harsh and more perishing, or much sooner decays.

3. In a *plane* a Voice may be heard at a far greater distance, then in uneven ground.

The *Reason* of all which last nam'd *Phænomena* is the same, because the Sonorous air meeting with little or no resistance upon a *Plane* (much less upon an Arch'd) smooth superficies, easily rous along it, without being let or hindred in its Motion, and consequently without having its parts disfigur'd, and put into another kind of Revolution, then what they had at the first begetting of the Sound. Which is the true cause of its *Preservation* or *Progression*; and fails much when the air passes over an uneven surface, according to the degrees of its inequality, and somewhat also, when it passes over the plane superficies of a body, that is hard and resisting.

Wherefore the smooth top of the *Water* (by reason of its yielding to the Arch'd air, and gently rising again with a kind of resurge, like to *Elasticity*, though it be not so; by which resurge it quickens and hastens the motion of the air rousing over it, and by it's yielding preserves it in it's Arch'd Cycloidical or Eliptical Figure) the smooth top of the water, I say, for these reasons, and by these means, conveys a Sound more entire and to a greater distance, then the plane surface of a piece of ground, a wall, or any other Solid Body whatever can do.

As for the *Speaking Trumpet*, by which a voice may be conveyed to a considerable distance, I refer it's consideration to that of *Refracted Sounds* or *Refracted Audition*.

Thus much of the Improvements of Hearing, that respect it's *Obj* & which is *Sound*.

2. The

2. The *Organ* and *Medium* are to be consider'd. And,  
 1. The *Organ*, which is the *Ear*, is helpt much by placing it near a *Wall* ( especially at one end of an Arch, the Sound being begotten at the other ) or near the Surface of *Water*, or of *the Earth*; along which the Sounds are most easily and naturally convey'd; as was before declar'd. And 'tis incredible, how far a sound made upon the Earth ( by the trampling of a Troop of Horses, for Example ) may be heard in a still night, if a man laies his Ear close to the ground in a large plane.

*Otaoustick*s here come in for helping the *Ear*; which may be so contriv'd (by a right understanding the *Progression of Sounds*, which is the principal thing to be known for the due regulating all such kinds of Instruments ) as that the Sound might enter the Ear without any *Refraction*; but as now they are generally made I refer them to *Refracted Audition*.

2. As to the *Medium*, I know not how that, by any contrivance of Art, can advantage *Direct Hearing*, otherwise then I have declar'd already in the propagation or conveyance of Sounds; though to the *Refracting or Reflecting* of them it may very much conduce; of which presently.

And so I have done with the first part of my present undertaking, which is the *Comparison of Direct Vision and Audition*, as to their Improvements from Art. The rest follow.

Wherefore,

II. Concerning *Refracted Vision* and it's Comparison, I observe, that *Refracted Vision* is always made *Ex parte Medij*; as *Reflected* is *ex parte Objecti*. And therefore though *Direct Vision* may be help'd *ex parte Objecti, Medij* vel *Organi*; yet *Refracted* can be improv'd only *ex parte Medij*, and *Reflected ex parte Corporis oppositi* alone. Unless it be in a mixt or compound Vision, that is *Refracto-Reflext*, when the reflex rays pass to the Eye through a refracting Medium, such as the Medium Internum,



contain'd in the body of the Eye, always is. So that in truth all Vision is *Refracted*, by an Internal Refraction made in *ipso Oculo*.

And all that I have spoken of *Vision* holds true of *Hearing* also, both *Refracted* and *Reflext*, and therefore need not be repeated.

*Refracted Vision* arises from the different *Density*, *Figure* and *Magnitude* of the Medium; which is somewhat alter'd alſo by the divers *Incidence* of the Viſible raies. And ſo it is in *Refracted Hearing*, all theſe Cauſes concur to it's production, and ſome others to be hereafter conſider'd.

Now as any Object ( a man for example ) ſeen through a thicken'd air, by *Refraction* appears greater then really he is : So likewiſe a *Sound*, heard through the ſame thicken'd part of the *Atmoſphear*, will be conſiderably vary'd from what it would ſeem to be, if heard through a thinner Medium.

And this I call a *Refracted Sound*. But what this Refraction of Sound is, and how cauſ'd, may hereafter be diſcuſs'd, when the nature and motion or progreſſion of Sounds are well ſtated.

For the Improvement of *Refracted Vision* artificial Inſtruments have been made, by grinding or blowing Glaſſes into a certain Figure, and placing them at due diſtances; whereby the Object may be ( as 'twere ) enabled to ſend forth it's raies more vigorouſly, and the Viſive Faculty impow'ered the better to receive them. And thus alſo inſtruments may be contriv'd for the aſſiſting both the *Sonorous Body*, to ſend forth it's Sound more ſtrongly, and the *Acouſtick Faculty* to receive and diſcern it more eaſily and clearly.

For,

1. As a fine *Glaſs Bubble*, fill'd with clear water, and plac'd before a burning Candle or Lamp, does help it to dart forth it's raies to a prodigious length and brightneſs:  
So

So an *Instrument* may be invented, that apply'd to the *Mouth* ( or any Sonorous body ) shall send forth the voice distinctly to as prodigious a distance and loudness.

For if the *Stentoro-phonecon* ( which is but a rude and unartificial Instrument. ) does such great feats; what might be done with one compos'd according to the rules of Art? whose *make* should comply with the Laws of *Sonorous Motion* ( which that does not ) and therefore not so much *Refract*, as to alter and confound the *Tone* of the *Voice* and words ( as that somewhat does. )

Now of what use such an Instrument might be for speaking clearly and articulately at a distance, ( and that without altering the *Tone* of the *Voice* ) whether it be at Sea or at Land ( but especially at Sea in tempestuous weather and in the night ) is obvious to any man to conceive.

2. As Instruments have been invented to help the *Eye*. So likewise are there some, and more such there may be, for the *Ear*.

For,

1. As *Spectacles* and other *Glasses* are made to help the *Purblind* and weak *Eyes*, to see at any competent distance: So there are *Otaoustickes* ( and better may be made ) to help weak *Ears* to hear at a reasonable distance also. Which would be as great a help to the infirmity of Old Age, as the other invention of *Spectacles* is, and perhaps greater; forasmuch as the Hearing what's spoken is of more daily use and concern to such men, then to be able to *Read Books* or to *View Pictures*.

2. As *Perspectiv-Glasses* and *Telescopes* help the *Eye* to see Objects at a very great distance, which otherwise would not be discernable; in like manner may a sort of *Otaoustickes* be so contriv'd as that they shall receive in *Sounds* made at a very great distance also; but with so much advantage, that the *Ear* shall be able to hear them, which otherwise would have been *inaudible*.

And these *Otaousticks* in some respects would be of greater use then *Perspectives*. For whereas at land *Perspectives* are many times render'd almost useles, by the interposition of Woods and Mountains, which hinder the *Sight* from reaching very far : our *Otaousticks* would, notwithstanding these Obstacles, take in a Sound made some leagues off. Which might be of notable use in the time of War, for discovering the Enemy at a good distance, when he marches or lyes incamp'd behind a Mountain or Wood, or any such place of shelter.

Yea even at *Sea* also, where *Perspectives* are of most use, by reason of the plainness of the surface of the Water ; Yet sometimes there *Otaousticks* may be of more benefit, when in dark, hazy weather the air is too thick, or in Stormy Tempestuous weather the Waves rise too high, for the *Perspective* to be made use of.

But whether at *Sea* or *Land*, *Perspectives* become altogether insignificant in the night time ( unless it be for viewing the Stars ) which is the chief time for using *Otaousticks* ; as it is generally, for Souldiers to take their march, when they would surprise their Enemies.

And therefore this sort of *Otaousticks* have then their chief use, when *Perspectives* are of no use at all ; besides that they may be employ'd in the day time, as well as *Perspectives* ; whence they may ( not unfitly ) be term'd *the most useful Instrument* of the two.

3. As *Microscopes* or *Magnifying Glasses*, help the *Eye* to see near *Objects*, that by reason of their smallness were *Invisible* before ; which *Objects* they *Magnify* to a strange greatness : So *Microphones* or *Micraousticks* , that is, *Magnifying Ear Instruments* may be contriv'd after that manner, that they shall render the most minute Sound in nature distinctly *Audible*, by *Magnifying* it to an unconceivable loudness.

By the help hereof we may hear the different cries and tones, as well as by *Microscopes* see the divers Shapes and

Figures , of the smallest Animals.

4. As by *Polyscopes* or *Multiplying Glasses*, one thing is represented to the *Eye* as many, whether in the same or different shapes ( for so multiplying Glasses may be contriv'd: ) so by a *Polyphone* or *Polyacoustick* well order'd one *Sound* may be heard as many, either of the same or a different Note. Insomuch that who uses this Instrument, he shall at the Sound of a single Viol seem to hear a whole Confort, and all true Harmony. By which means this Instrument has much the advantage of the *Polyscope*.

And thus much may suffice for comparing the Improvements made upon *Refracted Seeing and Hearing* ; I call it *Refracted Hearing*, because made through a *Medium*, viz. thick Air or an Instrument, through which the Sound passing is broken or refracted.

III. *Reflected Vision* has been improv'd by the invention of *Looking-Glasses* and *Polish'd Metals* whether *Plane*, *Concave* or *Convex*, and these two last either *Spherical*, *Oval*, *Cylindrical*, *Conical*, *Hyperbolical*, or of several other shapes ; all which cause a different reflection, and vary the *Phænomena*.

Thus also *Reflex'd Audition*, made by *Echoes*, may be improv'd, by contriving several sorts of *Artificial Echoes* ; as 'tis no hard matter to do in almost any place.

For ( Speaking in the general ) *Any Sound, falling directly or obliquely upon any dense body, of a Smooth ( whether Plane or Arch'd ) Surfaces, is beat back again and reflected, or does Echo more or less.*

I say ( 1 ) *falling directly or obliquely* ; because, if the Sound be sent out and propagated *parallel* to the Surface of the *Dense Body* or be made so *far off* and so *weak*, that it cannot reach it ; there will be no reflection of Sound, no *Echo*.

I say ( 2 ) *upon a body of a smooth superficies* ; because if the surface of the *Corpus Obflans* be uneven, the Air by  
re-

reverberation will be put out of it's regular Motion, and the Sound thereby broken and extinguish'd: So that tho' in this case also the air be beaten back again, yet Sound is not reflected, nor is there any Eccho.

I say (3) *it does Eccho more or less*, to shew, that when all things are, as is before describ'd, there is still an Echoing, though it be not always heard, either because the *Direct Sound* is too weak to be beaten quite back again to him that made it; or that it does return home to him, but so weak that without the help of a good *O-tacoustick* it cannot be discern'd; or that he stands in a wrong place to receive the reflected Sound, which passes over his head, under his feet, or to one side of him; which therefore may be heard by a man standing in that place, where the reflected Sound will come, provided no interpos'd body does intercept it; but not by him, that first made it.

I shall further make out the comparison 'twixt *Reflex'd Vision* and *Audition* by these following *Propositions*.

1. As a *Plane Speculum* reflects the *Object* in it's due *Dimensions* and *Colours*; allowing for their difference of appearance according to their distance: So a *Plane Corpus Obstans* reflects the *Sound* back in it's due *Tone* and *Loudness*; if allowance be likewise made for the proportionable decrease of the Sound according to it's distance.

2. As a *Convex Speculum* reflects the *Object Less*, but somewhat *brighter* or clearer: So a *Convex Corpus Obstans* repels the Sound (insensibly) *smaller*; but somewhat *quicker* (though *weaker*) then otherwise it would be.

3. As a *Concave Speculum* reflects the *Object Bigger*, more *Obscure* and *Inverted*: So a *Concave Corpus Obstans* Echoes back the Sound (insensibly) *Bigger*, *Slower* (though *stronger*) and also *inverted*; but never according to the order of words. Nor do I think it possible for the Art of man to contrive a *Single Eccho*, that shall invert the Sound and repeat backwards; because then the words last spoken,

spoken, that is, which do last occurre to the *Corpus Ob-  
stans*, must first be repell'd; which cannot be. For  
where in the mean time should the first words hang and be  
conceal'd or lie dormant? Or how, after such a pause, be  
reviv'd and animated again into Motion? Yet in com-  
plicated or *Compound Ecchoes*, where many receive from  
one another, I know not whether something that way  
may not be done.

From the *determinate Concavity* or *Archedness* of these  
reflecting bodies it comes to pass, that some of them,  
from a certain distance or posture, will Eccho back but  
one determinate Note, and from no other place will  
they reverberate any; because of the undue position of  
the Sounding Body. Such an one (as I remember) is  
the Vault in *Merton Colledge* in *Oxford*.

4. As a *Speculum* takes in and reflects more of it's Ob-  
ject, when plac'd at a great distance from it, then when  
nearer; because it reflects according to the apparent  
magnitude of the body at such a distance, which is less:  
So also the *Ecchoing body*, being remov'd farther off,  
reflects more of the Sound, then when nearer. And this  
is the reason, why some Ecchoes repeat but one Syllable,  
some one Word, and some many.

5. As *Specula's* may be so plac'd, that reflecting one  
upon or into the other, either directly or obliquely, one  
Object shall appear many; as in *Sir Samuel Morlands*  
*Glass-room*: After the same manner *Ecchoing bodies* may  
be so contriv'd and plac'd, as that reflecting the Sound  
from one to the other, either directly and mutually, or  
Obliquely and by Succession, out of one Sound shall  
many Ecchoes be begotten; which in the first case will be  
all together & somewhat involv'd or swallowed up of each  
other; and thereby confus'd (as a face in Looking-glasses  
obverted;) in the other they will be distinct, separate and  
succeeding one another; as most *multiple Ecchoes* do.

Moreover a *Multiple Eccho* may be made, by so place-  
ing

ing the *Ecchoing bodies*, at unequal distances, that they reflect all one way, and not one on the other; by which means a manifold successive Sound will be heard ( not without astonishment; ) one clap of the hands like many, one ha like a laughter, one single word like many of the same tone and accent, and so one Viol like many of the same kind imitating each other.

Furthermore, as *Specula's* may be so order'd, that by Reflection they shall make one single thing appear many different things; as one single man to seem many men differing as to shape and complexion ( or a company of men ) which I think Sir *Samuel Morlands* contrivance does not: So may *Ecchoing Bodies* also be order'd, that from any one Sound given, they shall produce many Ecchoes, different both as to their *Tone* and *Intension*. ( The ground whereof has elsewhere been laid down in a Treatise concerning the *Sympathy of Lute-Strings*.)

By this means a *Musical Room* may be so contriv'd, that not only one Instrument, played on in it shall seem many of the same sort and size; but even a Consort of ( somewhat ) different ones; only by placing certain *Ecchoing Bodies* so, as that any Note ( play'd ) shall be return'd by them in 3<sup>ds</sup> 5<sup>ths</sup> and 8<sup>ths</sup>, which is possible to be done otherwise then was mention'd before in *Refracted Audition*.

I have now done with my *Comparison* of the two Noblest *Senses* and *Sciences* as to their *Improvements*, wherein I have been thus large, that I might give you a little prospect into the *Excellency* and *Usefulness* of *Acousticks*, and that thereby I might excite all that hear me, to bend their thoughts towards the making of Experiments for the compleating this ( yet very imperfect, though noble ) Science; a *Specimen* whereof I will give you in three *Problemes*, and then present you with the *Semiplane* of an *Acoustick* or *Phonical Sphear*, as an attempt to explicate the great *Principle* in this Science, which is *The Progression of Sounds*. The

*The Problems are these,*

1. *Sonum intendere quousque velis; or, Datum sonum ad datum gradum intendere.*

2. *Sonum Extendere quousque velis; or, Datum Sonum ad datum distantiam extendere seu propagare.*

3. *Sonum transire ab extremo ad extremum et non per Medium.*

1. The first is, *To make the least Sound* (by the help of Instruments) *as loud as the greatest; a whisper to become as loud as the shot of a Canon.*

By the help of this *Probleme* the most minute Sounds in nature may be clearly and distinctly heard.

2. The second is, *To propagate any (the least) Sound to the greatest distance.*

By the help hereof any Sound may be convey'd to any, and therefore heard at any, distance, (I must add, within a certain, though very large Sphear.)

Moreover by this means a *Weather-cock* may be so contriv'd, as that with an ordinary blast of Wind it shall crie (or whistle) loud enough to be heard many Leagues. Which happily may be found of some use, not only for *Pilots* in mighty tempestuous weather, when *light houses* are render'd almost useles: But also for the measuring the strength of Winds, if allowance be made for their different Moysture. For I conceive, that the more drie any wind is, the louder it will whistle *ceteris paribus*; I say, *ceteris paribus*, because, besides the strength and drieness of Winds or breath, there are a great many other things (hereafter to be consider'd) that concur to the increase or magnifying of Sounds, begotten by them in an Instrument exposed to their violence, or bownd into.



3. The third *Probleme* is, *That a Sound may be convey'd from one extreme to the other* ( or from one distant place to another ) *So as not to be heard in the middle.*

By the help of this *Probleme* a man may talk to his freind at a very considerable distance, so that those in the middle space shall hear nothing of what passed betwixt them.

Fig. 2.

*Semiplanum Sphæræ Phonicæ seu Acousticæ.*

You are to conceive that ( rude ) *Semiplane*, as Parallel to the *Horizon*. For if it be Perpendicular thereunto, I suppose the upper extremity will be no longer *Circular*, but *Hyperbolical*, and the lower part of it suited to a greater Circle of the Earth. So that the whole *Phonical* Sphear ( if I may so call it ) will be a Solid *Hyperbola*, standing upon a *Concave Spherical Base*. I speak this concerning *Sounds* made ( as usually they are ) nigh the Earth, and whose Sonorous *medium* has a free passage every way. For if they are generated high in the Air, or directed one way, the case will be different ; which is partly design'd in the inequality of that draught.

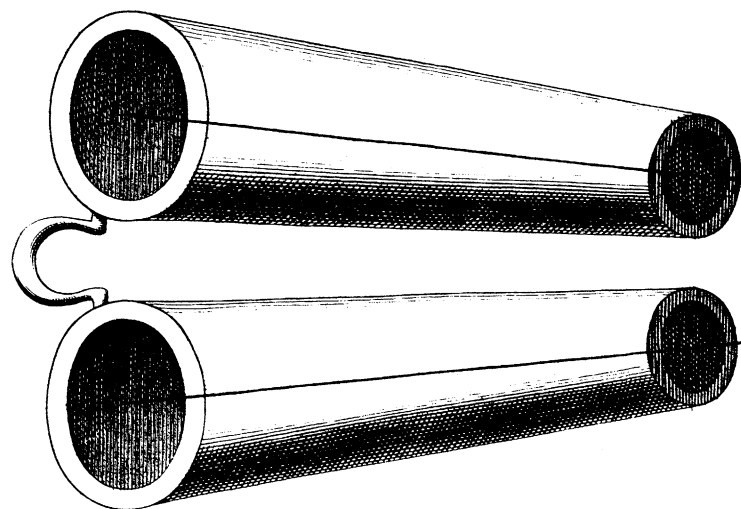
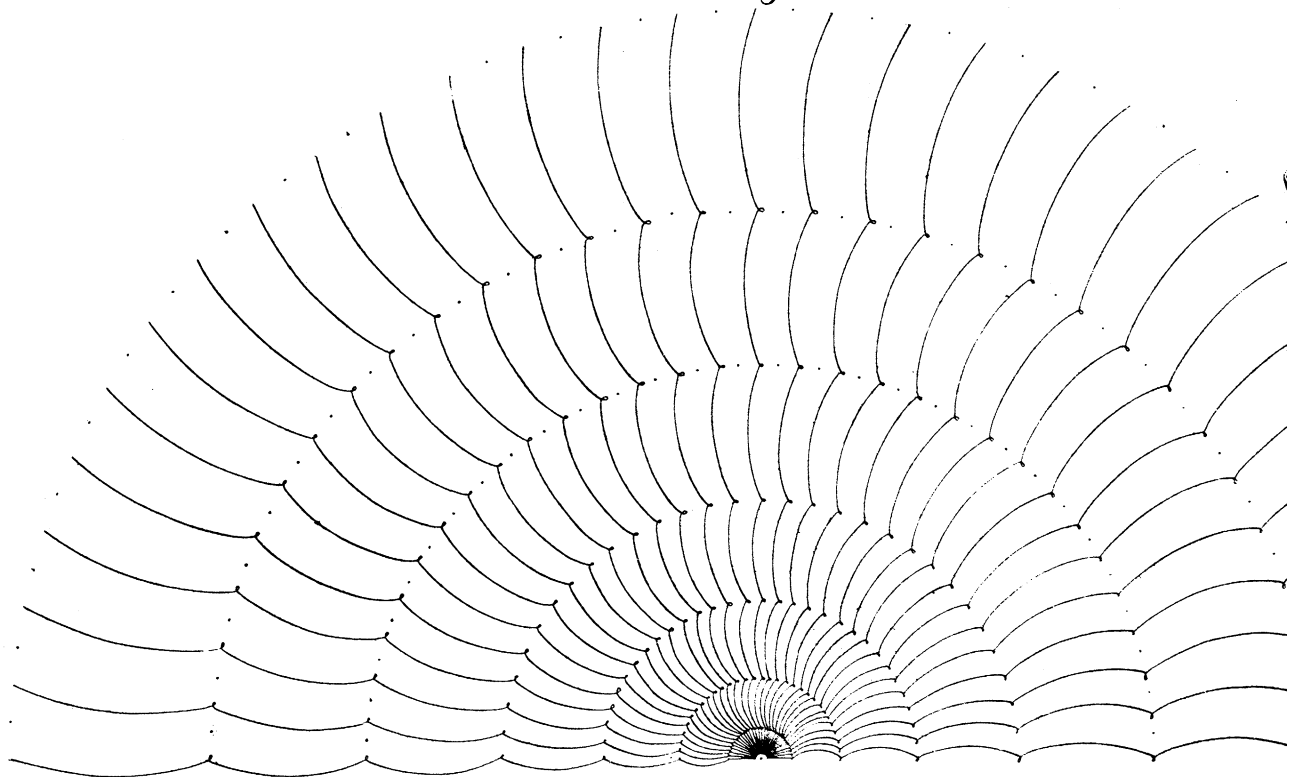
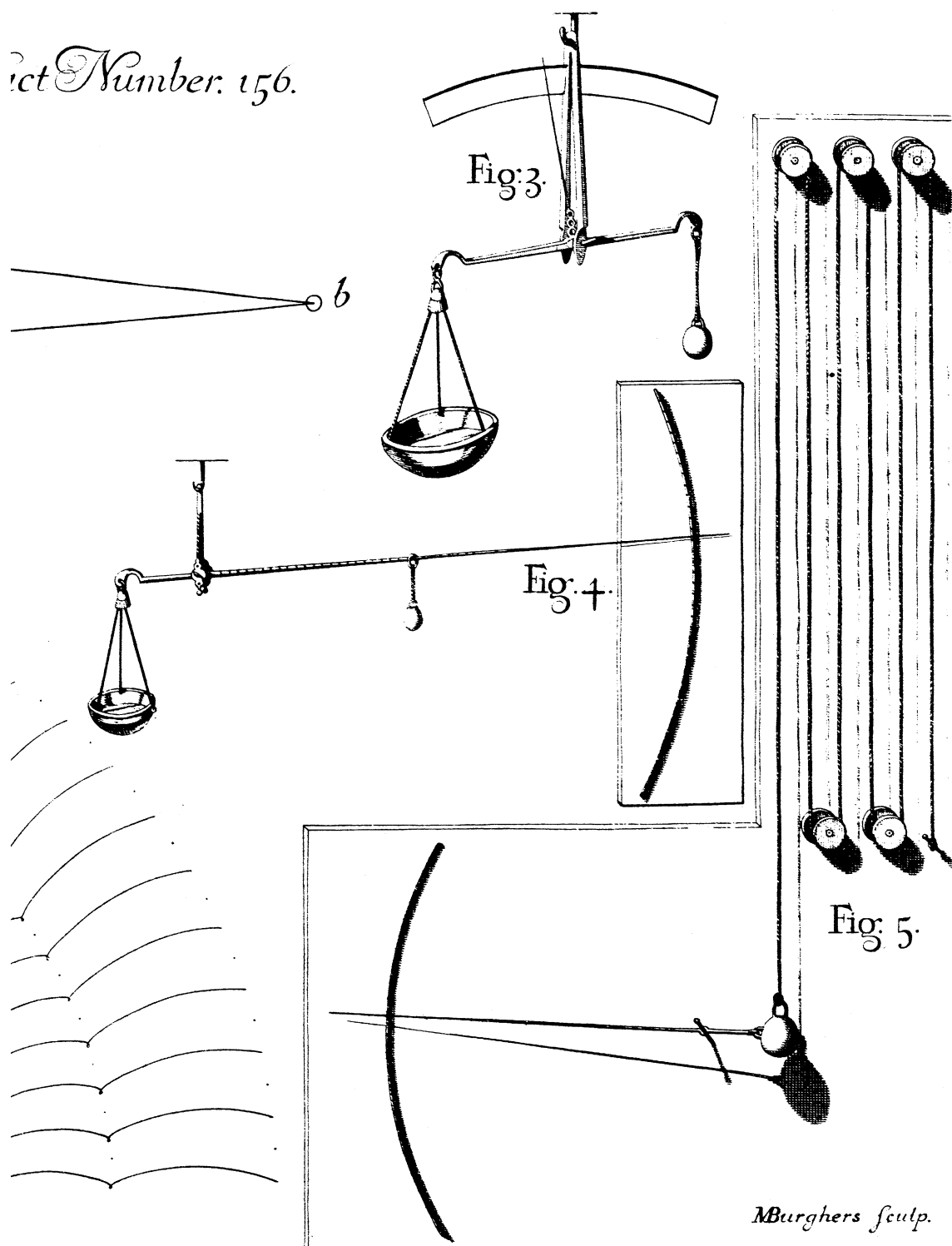


Fig. 1.

Fig. 2.



Act Number. 156.



M. Burghers sculp.

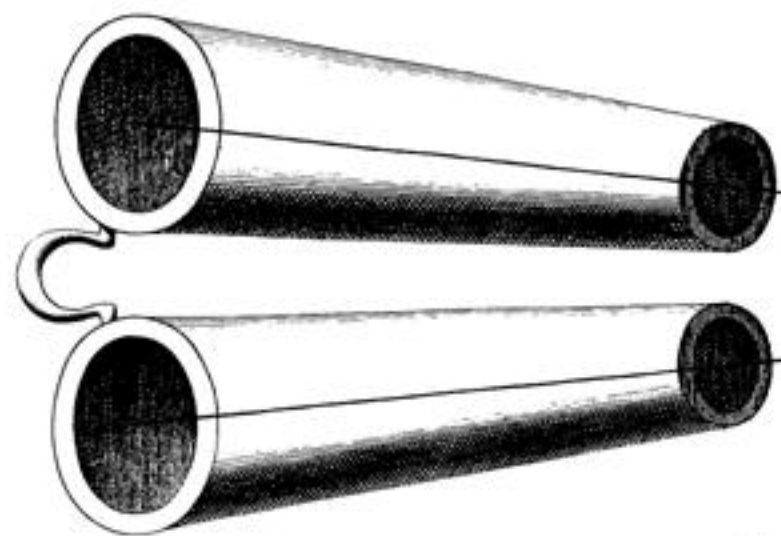


Fig. 1.

b

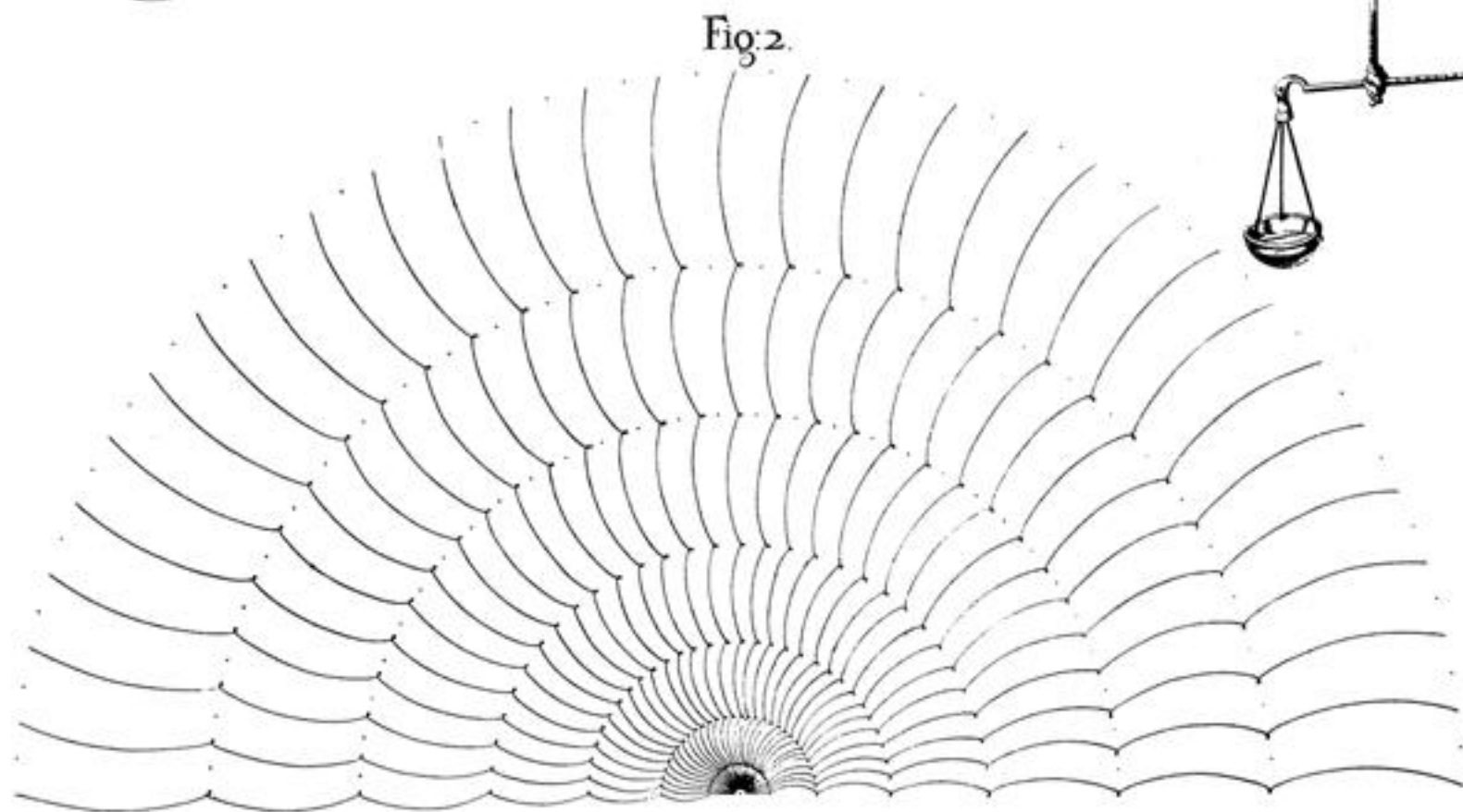


Fig. 2.

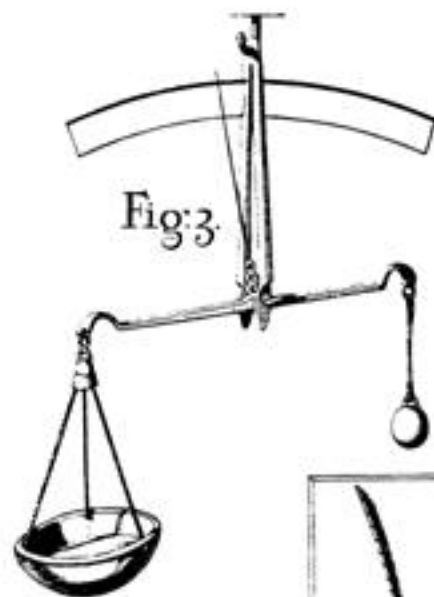


Fig. 3.

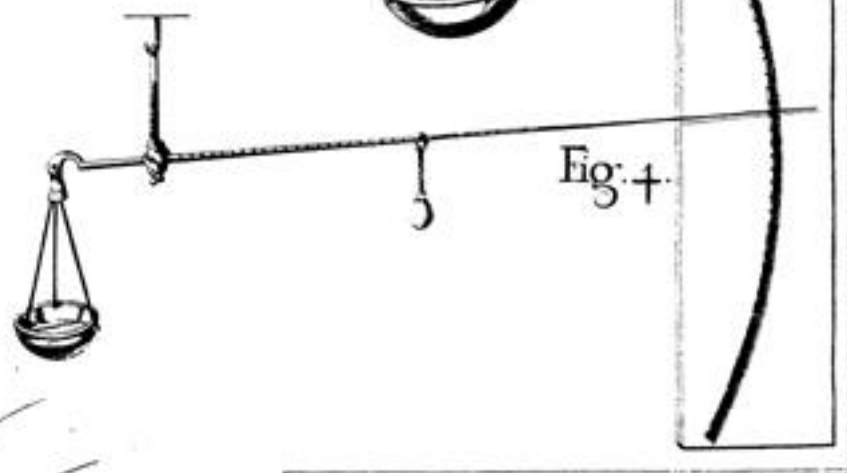


Fig. 4.



Fig. 5.

